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Four new morel (*Morchella*) species in the elata subclade (*M.* sect. *Distantes*) from Turkey

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Abstract—Four Turkish *Morchella* species identified in published multilocus molecular phylogenetic analyses are described here as new, using detailed macro- and microscopic data: *M. mediterraneensis* (*Mel*-27), *M. fekeensis* (*Mel*-28), *M. magnispora* (*Mel*-29), and *M. conifericola* (*Mel*-32). A distribution map of morels identified to date in Turkey is also provided.

Key words—*Ascomycota*, conservation, edible fungi, *Morchellaceae*, systematics, taxonomy

Introduction

True morels (*Morchella*), among the most highly prized edible macrofungi, are classified in the *Morchellaceae* (*Pezizales, Ascomycota*). This monophyletic family also includes *Disciotis*, *Kalapuya*, *Fischerula*, *Imaia*, *Leucangium*, and *Verpa* (O'Donnell et al. 1997, Trappe et al. 2010). Several multilocus DNA sequence-based analyses of *Morchella* that employed phylogenetic species recognition based on genealogical concordance (GCPSR sensu Taylor et al. 2000) have revealed that most species exhibit continental endemism and provincialism in the northern hemisphere (Du et al. 2012a, b; O'Donnell

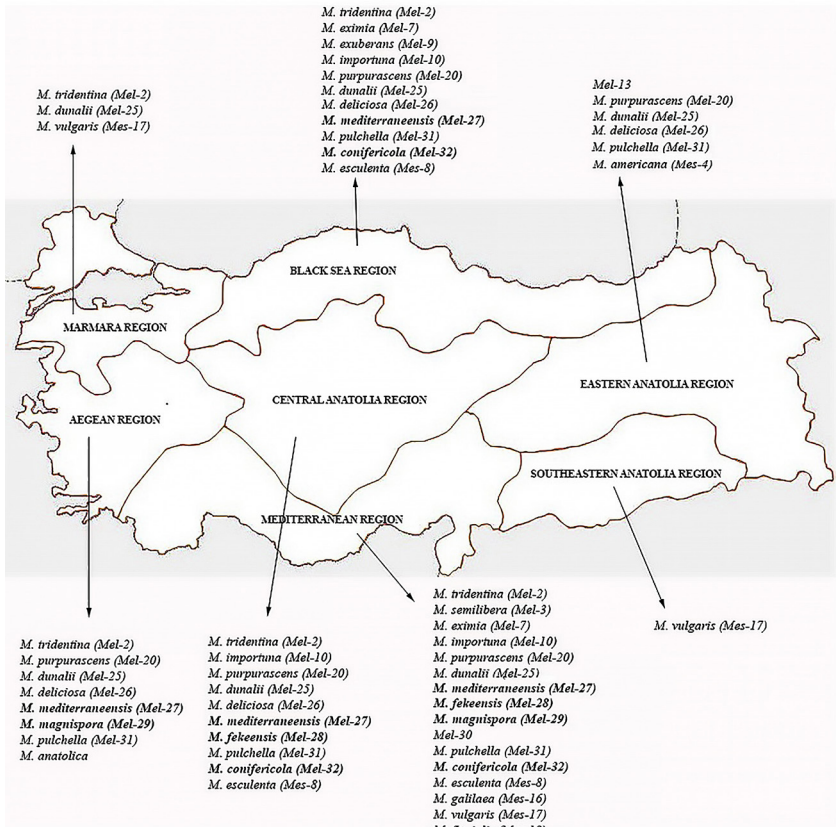


Fig. 1. Distribution of *Morchella* species in the seven geographic regions of Turkey

et al. 2011; Richard et al. 2015; Taşkın et al. 2010, 2012). These studies have also helped evaluate recent systematic studies based on morphological species recognition (Clowez 2012, Clowez et al. 2014) and provided a robust framework for taxonomic revision (Kuo et al. 2012, Richard et al. 2015).

Twenty-one of the 65 genealogically exclusive *Morchella* species discovered to date have been reported from Turkey (Işıloğlu et al. 2010; Taşkın et al. 2010, 2012). GCPSR-based studies of 491 Turkish collections, which included *M. anatolica* Işıloğlu et al. from the southwestern Anatolia region, recognized six undescribed species within the elata subclade (*M.* sect. *Distantes*). The undescribed species within this clade were assigned informal code names consisting of *Mel* followed by a unique Arabic number (Fig. 1). Here, four of these phylogenetically distinct species—previously reported as *Mel*-27, *Mel*-28,

Mel-29, and *Mel*-32 (Taşkın et al. 2010, 2012)—are formally described as new species.

Materials & methods

Specimens examined here were collected in different regions of Turkey from 2007 through 2010 (Fig. 1) and then deposited in the Ankara University Herbarium, Ankara, Turkey (ANK). The Munsell Book of Color (Munsell 1976) was used as the reference for all colors reported. Microscopic characters were measured with a Leica DM 3000 compound microscope at 400× magnification of mounts using Melzer's reagent, 2% KOH, or water. Light microscopic images were obtained using bright field optics. At least 20 mature ascospores were measured from each specimen, with Q values (length divided by width) determined from water mounts from dried specimens. The new term "acroparaphyses" (proposed by Loizides et al. 2016) is used for the sterile elements of the ridges.

Scanning electron micrographs were obtained following Elliott et al. (2014): an approximately 3 × 3 mm^2 piece of hymenium was excised from an air-dried ascocarp and rehydrated in 500 µL of sterile distilled water in a 1.5 mL Eppendorf tube. The hydrated hymenium was macerated gently with a pipette tip to dislodge intact ascospores and then vortexed briefly. After precipitation of the large hyemnial fragments, the ascospore suspension was transferred to a new 1.5 mL Eppendorf tube and washed with two exchanges of distilled water. An aliquot of the suspension was then pipetted onto a microscope cover slip mounted on a SEM stub where it was airdried. Dried samples were coated with gold-palladium prior to examination with a JEOL 6400V scanning electron microscope.

Pure cultures of three of the four holotypes described here were obtained following a published protocol (O'Donnell et al. 2011) and deposited in the ARS Culture Collection (http://nrrl.ncaur.usda.gov/), National Center for Agricultural Utilization Research, Peoria IL, USA (NRRL), where they are stored in liquid nitrogen vapor at –75°C in a cryogen composed of 1% DMSO and 10% skim milk.

Taxonomy

Morchella mediterraneensis Taşkın, Büyükalaca & H.H. Doğan, **sp. nov.** Figs 2–4

MycoBank MB 813585

Differs from *Morchella snyderi*, its reciprocally monophyletic sister species in the western United States, by distinctly smaller spores and young specimens with greenbluish tinges and dark ridges.

Type—Turkey, Kayseri, Yahyalı, 37°48'08"N 35°18'03"E, 1618 m, under *Abies cilicica* (Antoine & Kotschy) Carrière, 8 May 2010, coll. Taşkın 478, (**Holotype**, ANK Taşkın 98; ex-type culture, NRRL 53842).

Etymology—from the Mediterranean biogeographical area, to reflect the widespread distribution of this species in southern Turkey.

Ascomata medium-sized, with conical pileus attached to the stipe with a deep narrow sulcus, edges dark violet to black and pits gray to olive gray with

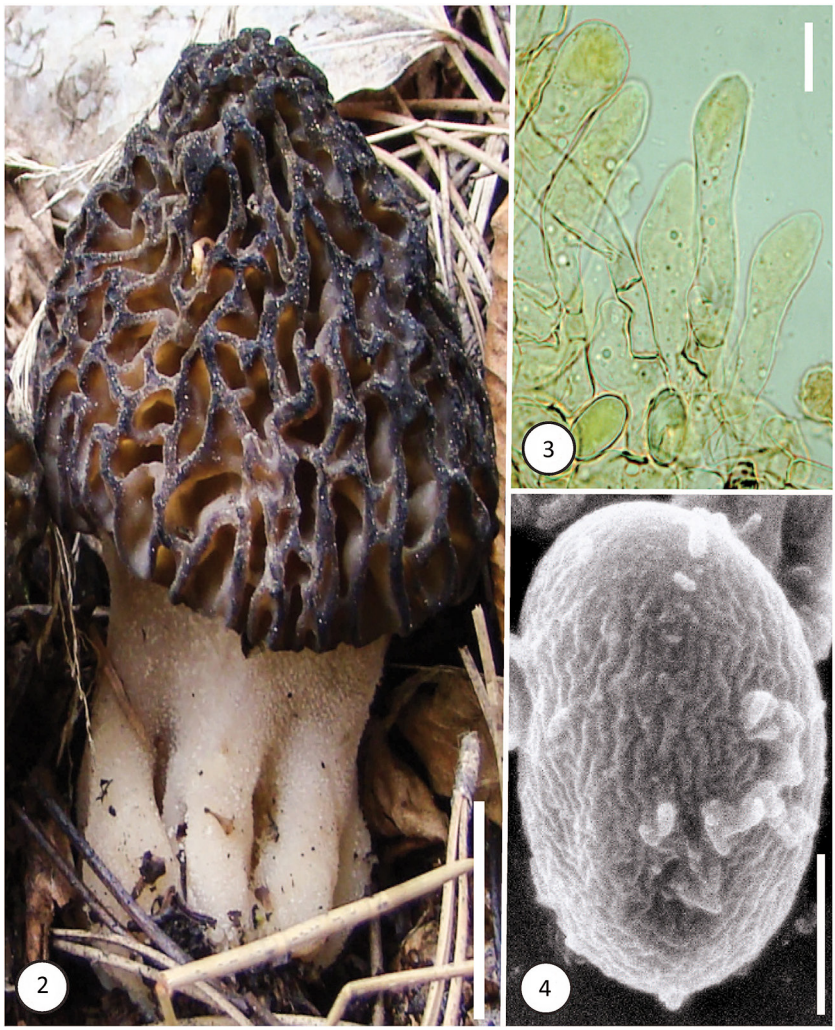
bluish tinges turning light honey brown to dark golden brown with age. Spores measuring 20–24 × 11.2–13.8 µm, faintly wrinkled when viewed by scanning electron microscopy. Paraphyses 2–4-septate, terminal cell cylindrical to subclavate, 12–15 µm diam. Acroparaphyses lanceolate to clavate, 10–23 µm diam, thick-walled.

Macromorphological characters — Ascomata 25–60 mm high, stipe often constricted at the base. Pileus hollow, at first bluntly conical to broadly ovoid-elliptical or cylindrical, then conical to sharply conical at the tip, 20–50 mm at broadest point, pitted and ridged, attached to the stipe by a distinct narrow (but often deep) sulcus (sinus); ridges 1–3 mm broad, primary ridges 15–20 per ascoma, longitudinal from base to tip of ascoma, a few shorter, connected by secondary cross-ridges, 5–10 horizontally oriented; edges minutely granular, uniformly dark violet-black (5PB2/6) at first, black (2.5B 1/2) at maturity. Pits irregular, generally with 3–5 sides, surface granulose, light gray to light olive gray with bluish tint (N5) at first, light honey brown (7.5YR 7/10) to dark golden brown (7.5YR 5/8) at maturity. Stipe cylindrical to laterally compressed, usually widening at base with coarse ridges or folds, hollow, 20–50 mm high, 5–30 mm wide, increasingly covered with minute whitish granules with maturity, entirely cream-white (N9) when young, light honey brown (7.5YR 7/10) at maturity. Sterile inner cavity white to light honey yellow at first, turning light honey brown (7.5YR 7/10) and finely granular as ascocarps mature.

Micromorphological characters — Ascospores (18–)20–24(–25) × (11.2–)12–13.8(–14.6) µm, mean Q = 1.77; elliptical to oblong, hyaline, surface distinctly wrinkled under SEM; spore wall ± 0.7 µm thick. Asci cylindrical, straight, (270–)290–320(–320) × (17–)19–22(–25) µm, 8-spored, hyaline, thin-walled without crozier. Paraphyses shorter than asci, terminal cell cylindrical, subclavate, (200–)220 × 270(–290) × 12–15 µm; 2–4-septate. Acroparaphyses straight; clavate, lanceolate to subclavate, very rarely subcapitate, capitate elements absent; 70–170 × 10–23 µm, 2–5-septate, terminal cell 70–110 µm long, wall thickness 1.3–1.5 µm, usually filled with refractory material, wall deposit light yellowish orange.

Ecology and distribution — *Morchella mediterraneensis* was collected under *Pinus brutia*, *P. nigra*, *Cedrus libani*, *Juniperus excelsa*, *J. foetidissima*, *Abies cilicica*, and *Quercus coccifera* in Adana, Mersin, and Kahramanmaraş provinces in the Mediterranean region, Konya and Kayseri provinces in the Central Anatolia region, Denizli province in the Aegean region, and Kastamonu province in the Black Sea region (Taşkın et al. 2010, 2012).

Additional collections examined — **TURKEY**: **Mersİn**, Erdemli, 36°42′07″N 33°59′56″E, 1335 m elev., under *P. brutia*, *A. cilicica*, *J. excelsa*, *J. foetidissima*, 16 April



Figs 2–4. *Morchella mediterraneensis* (Taşkın 478, holotype). 2. Ascocarp. 3. Clavate acroparaphyses on ridge. 4. SEM of ascospore with irregular striae. Scale bars: 2 = 1 cm; 3 = 20 µm; 4 = 5 µm.

2007, coll. Taşkın 25 (ANK Taşkın 47); **Kahramanmaraş**, Göksun, 38°08′00″N 36°35′04″E, 1685 m elev., under *P. brutia*, *P. nigra*, *J. excelsa*, *J. foetidissima*, *A. cilicica*, 5 May 2008, coll. Taşkın 207 (ANK Taşkın 37, ANK Taşkın 38); **Kastamonu**, Ağlı, 19 May 2008, coll. Taşkın 107, 118 (ANK Taşkın 53, ANK Taşkın 55); **Adana**, Feke, 37°57′18″N 35°48′12″E, 1632 m elev., under *P. nigra*, *C. libani*, *A. cilicica*, *J. excelsa*, *J. foetidissima*, 14 April 2010, coll. Taşkın 520 (ANK Taşkın 100); **Konya**, Beyşehir,

37°37′36″N 31°20′13″E, 1665 m elev., under *P. nigra*, *C. libani*, *A. cilicica*, 5 May 2010, coll. Taşkın 448 (ANK Taşkın 97);. **Kayseri**, Yahyalı, 37°48′08″N 35°18′03″E, 1618 m elev., under *A. cilicica*, 8 May 2010, coll. Taşkın 481 (Çukurova Univ.). **SPAIN**: **Malaga**, Parauya, Parco Natural de la Sierre de las Nieves, 1100 m elev., under *Abies pinsapo*, 8 May 2013, M. Becerra Parra (LIP, Clowez PhC252).

Comments—*Morchella mediterraneensis* was previously reported as *Mel*-27 (Du et al. 2012a, b; Taşkın et al. 2010, 2012); it was the second most common morel collected in Turkey, representing 83 of the 491 collections. Of these, 67/83 were from the Mediterranean region (Taşkın et al. 2012). Collections from Greece (Loizides et al. 2016) and Spain (M. Becerra Parra, ex herb. P. Clowez) confirm that its distribution extends beyond the Turkish borders and that it might be even more widespread in the Mediterranean basin. This species was strongly supported as the reciprocally monophyletic sister clade to *M. snyderi* (*Mel*-12), a species that is so far considered endemic to western North America (Kuo et al. 2012, Du et al. 2012a, O'Donnell et al. 2011, Taşkın et al. 2012). Maximum likelihood-based analyses suggest that the geographic range of the most recent common ancestor of *M. synderi* expanded via dispersal across the Beringian land bridge into western North America in the late Miocene to Pliocene (Du et al. 2012a). ITS rDNA sequence data cannot be used to distinguish *M. mediterraneensis* (*Mel*-27) from *M. pulchella* (*Mel*-31) from Turkey and France, *M. septentrionalis* (*Mel*-24) from eastern North America, and *Morchella* sp. (*Mel*-23) from northern Europe (Du et al. 2012b). Therefore, for a definitive identification, we recommend using portions of the four genes that resolved this species as genealogically exclusive (Taşkın et al. 2012). Morphologically, *M. mediterraneensis* is very similar to *M. dunalii* (*Mel*-25), which also displays dark edges and pale pits, but differs microscopically by strongly inflated to lobate acroparaphyses (Loizides et al. 2016). *Morchella kakiicolor*, known only from Spain and insufficiently documented regarding macromorphology, shows paler edges and a less conical shape (Loizides et al. 2015). *Morchella deliciosa* (*Mel*-26) and *M. purpurascens* (*Mel*-20) have pinkish to dark purplish tinges and a narrowly conical to cylindrical pileus that is at least twice larger than broad.

Morchella fekeensis H.H. Doğan, Taşkın & Büyükalaca, **sp. nov.** Figs 5–7

MycoBank MB 813587

Differs from *Morchella brunnea* and *M. snyderi*, its reciprocally monophyletic sister species in the western United States, by its genealogical exclusivity in a multigene phylogenetic analysis and apparent endemism in Turkey.

Type—Turkey, Yozgat, Akdağ madeni, 39°35′05″N 35°56′14″E, 1449 m, under *Pinus sylvestris* L., 29 April 2010, coll. Taşkın 401 (**Holotype**, ANK Taşkın 101; ex-type culture, NRRL 53820).

Figs 5–7. *Morchella fekeensis* (Taşkın 401, holotype). 5. Ascocarp. 6. Clavate acroparaphyses on ridge. 7. SEM of ascospore with longitudinal and irregular striae. Scale bars: 5 = 1 cm; 6 = 20 µm; 7 = 5 µm.

Etymology—referring to Turkey's Feke (Adana) province where some of the specimens were collected.

Ascomata small-sized, 10–30 mm high. Pileus cylindrical then bluntly conical or ovoid, with irregular, vertically arranged pits yellow-orange to yellow-brown with age, with granular surface. Stipe whitish at first, covered with whitish to

yellow orange granules with age. Ascospores 22.5–25.5 × 12.5–15.5 µm, wrinkled when viewed by scanning electron microscopy. Paraphyses 2–5-septate, terminal cell cylindrical, subclavate to subcapitate, 12–14 µm diam. Acroparaphyses lanceolate to clavate, 9.9–18.6 µm diam.

Macromorphological characters—Ascomata 10–30 mm high, stipe often constricted at base. Pileus hollow, ovoid-elliptical or cylindrical at first, then bluntly conical or ovoid at apex, 5–30 mm diam at widest point, pitted and ridged, attached to stipe with a distinct incurved sulcus; primary ridges 10–16 per ascoma, longitudinal from base to tip, with a few shorter vertical secondary ridges, and 5–8 horizontal cross-ridges; edges 1–2 mm broad, finely granular, light gray black (5PB 2/6) at first, dark black (2.5B 1/2) at maturity, transecting ridges bright yellowish brown (10YR 7/6). Pits irregular, generally with 2–5 sides, surface granulose, deeply sinuous, yellow orange (10YR 8/6) to bright yellowish brown (10YR 7/6) at first, then turning yellowish brown (10YR 5/8) to dark golden brown (7.5YR 5/8) at maturity. Stipe cylindrical to laterally compressed, usually tapered at base with thin ridges or folds, hollow, 5–30 mm high, 5–10 mm wide, increasingly covered with rough whitish to yellow orange granules (10YR 8/8) as ascocarps mature, completely cream-white when young, light honey brown (7.5YR 7/10) at maturity. Sterile inner cavity white to light honey yellow at first, turning light honey brown (7.5YR 7/10) at maturity.

Micromorphological characters—Ascospores 22.5–25.5(–27) × 12.5–15.5 µm, mean Q = 1.76; elliptical to oblong, hyaline, wall with straight to sinuous ridges often connected with low, crowded, transverse ridges under SEM, spore wall ± 0.7 µm thick. Asci crowded, cylindrical, straight, 240–300(–340) × 20–24 µm, 8-spored, hyaline, thin-walled. Paraphyses shorter than asci, terminal cell cylindrical, subclavate to subcapitate; 175–260 × 12–14 µm; 2–5-septate. Acroparaphyses straight; clavate, lanceolate to subclavate, very rarely subcapitate, capitate elements absent; 119–163 × 9.9–18.6 µm, 2–4-septate, terminal cell 50–110 µm long, usually filled with refractory material.

Ecology and distribution — *Morchella fekeensis* was collected under conifers (*Pinus brutia*, *P. nigra*, *P. sylvestris*, *Cedrus libani*, *Abies cilicica*, *Juniperus* sp.) in Adana and Kahramanmaraş provinces in the Mediterranean region, and Yozgat and Sivas provinces in the Central Anatolia region (Taşkın et al. 2010, 2012).

Additional collections examined — **TURKEY**: **Adana**, Feke, 37°51′56″N 35°48′05″E, 1325 m elev., under *P. brutia*, *P. nigra*, *C. libani*, *A. cilicica*, 20 April 2007, coll. Taşkın 50 (ANK Taşkın 03); **Kahramanmaraş**, Göksun, 38°08′15″N 36°34′20″E, 1630 m elev., under *C. libani*, *A. cilicica*, *Juniperus* sp., 22 May 2008, coll. Taşkın 201 (ANK Taşkın 45); **Sivas**, Koyulhisar, 40°21′05″N 37°54′56″E, 1963 m elev., under

P. brutia, *P. nigra*, *A. cilicica*, 27 May 2008, coll. Taşkın 251 (ANK Taşkın 62); **Yozgat**, Akdağ madeni, 39°35′05″N 35°56′14″E, 1449 m elev., under *P. sylvestris*, 29 April 2010, coll. Taşkın 507 (ANK Taşkın 102); Akdağ madeni, 39°34′47″N 35°56′40″E, 1593 m elev., under *P. sylvestris*, 29 April 2010, coll. Taşkın 510 (ANK Taşkın 103).

Comments — *Morchella fekeensis* was reported previously as *Mel*-28 (Du et al. 2012a, b; Taşkın et al. 2010, 2012). GCPSR-based studies strongly support the reciprocal monophyly of *M. fekeensis* and the western Northern American endemic, *M. brunnea* (*Mel*-22; Taşkın et al. 2010, 2012; O'Donnell et al. 2011), from which it differs mainly by smaller, less conical ascomata, distinctly smaller spores, and acroparaphyses that are not distinctly capitate. With only nine collections (six from Central Anatolia, three from the Mediterranean region), *M. fekeensis* appears to be relatively rare in Turkey. Maximum likelihood-based analyses suggest that the geographic range of the most recent common ancestor of *M. brunnea* expanded via a dispersal across the Beringian land bridge into western North America in the late Pliocene to Pleistocene (Du et al. 2012a). Preliminary data suggest that ITS rDNA sequences might be useful in distinguishing *M. fekeensis* from closely related elata subclade species (Du et al. 2012b). However, for a definitive identification, we recommend sequencing portions of the four genes that resolved this lineage as genealogically exclusive.

Morchella fekensis is one of the smallest species in *M.* sect. *Distantes*, characterized by a distinctly sulcate stipe that stains yellowish with age and a yellow to yellow-brown pileus with edges staining black with age. It belongs to the "*Mel*-17–34 complex," close to the European *M. pulchella* (*Mel*-31), the North American *M. septentrionalis* (*Mel*-24), and several still unnamed Eurasian species represented by single collections (Richard et al. 2015). Also described as small, *M. pulchella* is distinguished by its greenish-gray coloration and a non-sulcate stipe.

Morchella magnispora Büyükalaca, H.H. Doğan & Taşkın, **sp. nov.** Figs 8–10

MycoBank MB 813588

Differs from *Morchella brunnea* and *M. fekeensis*, its reciprocally monophyletic sister species, by its stipe turning honey-brown with age, its narrow sulcus, its genealogical exclusivity in a multigene phylogenetic analysis, and its apparent endemism in Turkey.

Type—Turkey, Uşak, Bahadır, 38°50′49″N 29°45′19″E, 1208 m, under *Pinus nigra*, 5 April 2010, coll. Taşkın 470 (**Holotype**, ANK Taşkın 104; ex-type culture, NRRL 53796).

Etymology—from Latin: *magnus* = large, *spora* = spore; referring to the large ascospores produced by this species.

Ascomata small- to medium-sized, with ovoid to bluntly conical pileus at first, sharply conical with age, attached to the stipe by a narrow sulcus; edges early dark violet then black; pits irregular and mostly tetragonal, light smoky brown when young, dark brown when mature; stipe initially white, in age light

honey brown. Ascospores 24–31 × 13–21 µm, faintly wrinkled when viewed by scanning electron microscopy. Paraphyses 1–3-septate, terminal cell cylindrical to subcapitate, 11–17 µm diam. Acroparaphyses lanceolate to clavate, rarely subcapitate, 13.6–30.5 µm diam.

Macromorphological characters—Ascomata 20–50 mm high, margin constricted where attached to stipe. Pileus hollow, slightly ovoid-elliptical or cylindrical to bluntly conical at first, then conical to sharply conical at the tip, 15–40 mm diam. at widest point, pitted and ridged; primary ridges longitudinal, 12–16 per ascoma, all from base of ascomata to tip, secondary ridges only horizontal, 6–10 per primary pit; edges finely granular, dark violet-black (5PB2/6) at first, dark black (2.5B 1/2) at maturity. Pits deeply irregular and tetragonal, surface granulose, light smoky brown (7.5YR 5/6) to brown (7.5YR 4/4) at first, then dark brown (7.5YR 3/4) at maturity. Stipe cylindrical to laterally compressed, usually widening at base with coarse ridges or folds, hollow, 30–70 mm long, 5–30 mm wide, increasingly covered with coarsely whitish granules as ascocarps mature, completely cream-white (N9) when young, light honey brown (7.5YR 7/10) at maturity. Sterile inner cavity white to light honey yellow at first, then light honey brown (7.5YR 7/10).

Micromorphological characters—Ascospores 24–31 × 13–21 µm, mean Q = 1.65; elliptical to oblong, hyaline, content homogeneous, polar oil drops absent, longitudinally striate when viewed via SEM; spore wall ± 0.5 µm thick. Asci crowded, cylindrical, straight, 230–350 × 15–25 µm, 8-spored, hyaline, thin-walled. Paraphyses shorter than asci, terminal cell cylindrical, subclavate, subcapitate, 190–250 × 11–17 µm; 1–3-septate. Acroparaphyses straight; clavate, lanceolate to subclavate, very rarely subcapitate, capitate elements absent; 143–192 × 13.6–30.5 µm, 2–4-septate, terminal cell 98–130 µm long, usually filled with refractory material.

Ecology and distribution — *Morchella magnispora* was collected under *Pinus brutia*, *P. nigra*, *Cedrus libani*, *Abies cilicica*, *Quercus coccifera*, and *Juniperus* sp. in Aydın and Uşak provinces in the Aegean region, and Adana, Kahramanmaraş, Mersin, and Muğla provinces in the Mediterranean region (Taşkın et al. 2010, 2012).

Additional collections examined — **TURKEY**: **Mersİn**, Gülnar, 36°18′20″N 33°25′57″E, 780 m elev., under *P. brutia*, 28 March 2007, coll. Taşkın 82 (ANK Taşkın 05); **Adana**, Feke, 37°51′56″N 35°48′05″E, 1325 m elev., under *C. libani*, *A. cilicica*, *Juniperus* sp., 20 April 2007, coll. Taşkın 45 (ANK Taşkın 23); **Muğla,** Fethiye, 36°50′38″N 29°07′14″E, 1048 m elev., under *P. brutia*, *Q. coccifera*, 15 April 2008, coll. Taşkın 189 (Çukurova Univ.); **Aydın,** Bozdoğan, 37°37′13″N 28°19′15″E, 819 m elev., under *P. brutia*, *P. nigra*, 17 April 2008, coll. Taşkın 155 (ANK Taşkın 04); **Uşak,** Bahadır, 38°50′49″N 29°45′18″E, 1216 m elev., under *P. nigra*, 5 April 2010, coll. Taşkın 471 (ANK Taşkın 105).

Figs 8–10. *Morchella magnispora* (Taşkın 470, holotype). 8. Ascocarp. 9. Clavate acroparaphyses on ridge. 10. SEM of ascospore with delicate striae. Scale bars: 8 = 1 cm; 9 = 20 µm; 10 = 5 µm.

Comments — *Morchella magnispora* was previously reported as *Mel*-29 (Du et al. 2012a, b; Taşkın et al. 2010, 2012). Only nine collections of this rare species were made, including six from the Aegean and three from Mediterranean region (Taşkın et al. 2012). *M. magnispora* was resolved as a reciprocally monophyletic sister to *M. fekeensis* + *M. brunnea*. Presumably the allopatric speciation of

the latter sister taxa was associated with the geographic range expansion of the most recent common ancestor of *M. brunnea* across the Beringian land bridge into western North America in the late Pliocene to Pleistocene (Du et al. 2012a). Preliminary data suggest that ITS rDNA sequences may be useful in distinguishing *M. magnispora* from closely related elata subclade species (Du et al. 2012b). *Morchella magnispora* is an distinctive species in the mainly Eurasian "*Mel*-17–34 complex" (Richard et al. 2015) in that the stipe turns honey-brown with age and the sulcus is narrow; it shares similarities with the North American species *M. brunnea* (*Mel*-22), including the brown colors with dark edges from young stages and large spores (which are longer than in other European species of *M.* sect. *Distantes* described, e.g., by Clowez 2012, but they fall within the broad spore range of *M. brunnea* as described by Kuo et al. 2012: "22–36(–40) × 14–20(–25) µm").

Morchella conifericola Taşkın, Büyükalaca & H.H. Doğan, **sp. nov.** Figs 11–13

MycoBank MB 813590

Differs from *Morchella septentrionalis* and *M. pulchella,* its reciprocally monophyletic sister species, by its genealogical exclusivity in a multigene phylogenetic analysis and its apparent endemism in Turkey.

Type—Turkey, Kayseri, Yahyalı, 37°48′08″N 35°18′03″E, 1618 m, under *Abies cilicica*, 8 May 2010, coll. Taşkın 477 (**Holotype**, ANK Taşkın 110).

Etymology — from Latin, *coniferi*: conifers (*Pinales*), and *cola* = to dwell or inhabit; referring to the distribution under conifers.

Ascomata small- to medium-sized, with elliptical to conical pileus becoming sharply conical with age, attached to the stipe with a narrow, incurved sulcus; edges dull orange at first then brownish black; pits irregularly polygonal, light yellow orange to bright brown at maturity; stipe not distinctly sulcate, white then light honey-brown at maturity, covered with coarse whitish granules. Ascospores (21–)22–25 × (10–)12–14 µm, distinctly striate when viewed by scanning electron microscopy. Paraphyses 3–5-septate, terminal cell cylindrical to subclavate, 10–15 µm diam. Acroparaphyses lanceolate to clavate, rarely subcapitate, 10–31.5 µm diam.

Macromorphological characters — Ascomata 30–60 mm high, margin constricted where attached to stipe. Pileus hollow, elliptical-cylindrical to conical at first, then conical to sharply conical at the tip, 15–25 mm diam. at widest point, pitted and ridged. Primary ridges 12–16 per ascoma, longitudinal from base of ascomata to tip, connected by 5–10 secondary cross-ridges; edges finely granular, dull orange (5YR 7/4) at first, brownish black (5YR 2/1) at maturity. Pits deeply irregular and tetragonal, surface granulose, light yellow

Figs 11–13. *Morchella conifericola* (Taşkın 477, holotype). 11. Ascocarp. 12. Clavate acroparaphyses on ridge. 13. SEM of ascospore with prominent longitudinal striae interconnected by delicate horizontal striae. Scale bars: 11 = 1 cm; 12 = 20 µm; 13 = 5 µm.

orange (7.5YR 8/3) to dull orange (7.5YR 7/3) at first, then bright brown (7.5YR 5/6) at maturity. Stipe cylindrical, slightly widening at base, coarse ridges or folds absent, hollow, 30–50 mm long, 5–20 mm wide, increasingly covered with coarse whitish granules, completely cream-white (N9) when

young, light honey brown (7.5YR 7/10) at maturity. Sterile inner cavity white to light honey yellow at first, then light honey brown (7.5YR 7/10) and finely granulose at maturity.

Micromorphological characters — Ascospores (21–)22–25 × (10–)12–14 µm, mean Q = 1.84; elliptical to oblong, hyaline, content homogeneous, polar oil drops absent, surface with longitudinal and anastomosing striations under SEM; spore wall ± 0.7 µm thick. Asci crowded, cylindrical, straight, (290–)300–370(–390) × (18–)20–23 µm, 8-spored, hyaline, thin-walled. Paraphyses shorter than asci, terminal cell cylindrical, subclavate, (190–)230–275(–300) × 10–15 µm; 3–5-septate. Acroparaphyses straight; clavate, lanceolate to subclavate, very rarely subcapitate, capitate elements absent; 85–185 × 10–31.5 µm, 3-septate, terminal cell 41–98 µm long, usually filled with refractory material.

Ecology and distribution — *Morchella conifericola* was collected under *Pinus nigra*, *Cedrus libani*, and *Abies cilicica* in Kastamonu province (Black Sea region), Kayseri province (Central Anatolia region) (Taşkın et al. 2010, 2012) and Kahramanmaraş province (Mediterranean region) (unpublished).

Additional collections examined — **TURKEY**: **Kayseri**, Yahyalı, 37°48′08″N 35°18′03″E, 1618 m elev., under *A. cilicica*, 8 May 2010, coll. Taşkın 479 (ANK Taşkın 111).

Comments—*Morchella conifericola* was previously reported as *Mel*-32 (Du et al. 2012a, b; Taşkın et al. 2012). This rare species was represented by a single collection from the Black Sea and two collections from the Central Anatolia regions. GCPSR-based studies strongly support *M. conifericola* as sister to *Mel*-23 + *M. septentrionalis* + *M. pulchella* (Taşkın et al. 2012). *Morchella conifericola* was nested phylogenetically within a poorly resolved clade with *M. pulchella* (*Mel*-31) from Turkey, China, and France, *M. septentrionalis* (*Mel*-24) from eastern North America, and *Morchella* sp. (*Mel*-23) from northern Europe. *Morchella septentrionalis* is theorized to have evolved from a Eurasian ancestor whose geographic range expanded into North America via the Beringian land bridge in the late Pliocene to Pleistocene (Du et al. 2012a). Preliminary data suggest that ITS rDNA sequences might be useful in distinguishing *M. conifericola* from closely related elata subclade species (Du et al. 2012b). However, for a definitive identification, we recommend using portions of the four marker loci that were used to resolve this lineage as genealogically exclusive.

Morchella conifericola shows morphological affinities with *M. magnispora* (*Mel*-29), from which it differs mainly by its stipe that lacks wrinkles (or possesses indistinct ones), and smaller spores that are distinctly striate under SEM. See also remarks under *M. magnispora*.

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Literature cited

Clowez P. 2012 ['2010']. Les morilles. Une nouvelle approche mondiale du genre *Morchella*. Bull. Soc. Mycol. Fr. 126: 199–376.

Clowez P, Alvarado P, Becerra M, Bilbao T, Moreau PA. 2014. *Morchella fluvialis* sp. nov. (*Ascomycota*, *Pezizales*): A new but widespread morel in Spain. Bol. Soc. Micol. Madrid 38: 23–32.

Du X-H, Zhao Q, O'Donnell K, Rooney AP, Yang ZL. 2012a. Multigene molecular phylogenetics reveals true morels (*Morchella*) are especially species-rich in China. Fungal Genet. Biol. 49: 455–469. http://dx.doi.org/10.1016/j.fgb.2012.03.006

Du X-H, Zhao Q, Yang ZL, Hansen K, Taşkın H, Büyükalaca S, Dewsbury D, Moncalvo J-M, Douhan GW, Robert VARG, Crous PW, Rehner SA, Rooney AP, Sink S, O'Donnell K. 2012b. How well do ITS rDNA sequences differentiate species of true morels (*Morchella*)? Mycologia 104: 1351–1368. http://dx.doi.org/10.3852/12-056

Elliott TF, Bougher NL, O'Donnell K, Trappe JM. 2014. *Morchella australiana* sp. nov., an apparent Australian endemic from New South Wales and Victoria. Mycologia 106: 113–118. http://dx.doi.org/10.3852/13-065

Işiloğlu M, Alli H, Spooner BM, Solak MH. 2010. *Morchella anatolica* (*Ascomycota*), a new species from southwestern Anatolia, Turkey. Mycologia 102: 455–458. http://dx.doi.org/10.3852/09-186

Kuo M, Dewsbury DR, O'Donnell K, Carter MC, Rehner SA, Moore JD, Moncalvo JM, Canfield SA, Stephenson SL, Methven A, Volk TJ. 2012. Taxonomic revision of true morels (*Morchella*) in Canada and the United States. Mycologia 104: 1159–1177. http://dx.doi.org/10.3852/11-375

Loizides M, Alvarado P, Clowez P, Moreau PA, Romero de la Osa L, Palazón A. 2015. *Morchella tridentina*, *M. rufobrunnea*, and *M. kakiicolor*: a study of three poorly known Mediterranean morels, with nomenclatural updates in section *Distantes*. Mycol. Progress 14: 13 (on-line). http://dx.doi.org/10.1007/s11557-015-1030-6

Loizides M., Bellanger JM, Clowez P, Richard F, Moreau PA. 2016. Combined phylogenetic and morphological studies of true morels (*Pezizales*, *Ascomycota*) in Cyprus reveal significant diversity, including *Morchella arbutiphila* and *M. disparilis* spp. nov. Mycol. Progress 15: 39 (on-line). http://dx.doi.org/10.1007/s11557-016-1180-1

Munsell AH. 1976. Munsell Book of Color: Glossy Finish Collection. Baltimore: Munsell.

O'Donnell K, Cigelnik E, Weber NS. 1997. Phylogenetic relationships among ascomycetous truffles and true and false morels from 18S and 28S ribosomal DNA sequence analyses. Mycologia. 89: 48–65. http://dx.doi.org/10.2307/3761172

O'Donnell K, Rooney AP, Mills GL, Kuo M, Weber NS, Rehner SA. 2011. Phylogeny and historical biogeography of true morels (*Morchella*) reveals an early Cretaceous origin and high continental endemism and provincialism in the Holarctic. Fungal Genet. Biol. 48: 252–265. http://dx.doi.org/10.1016/j.fgb.2010.09.006

Richard F, Bellanger JM, Clowez P, Hansen H, O'Donnell K, Urban A, Sauve M, Courtecuisse R, Moreau PA. 2015. True morels (*Morchella, Pezizales*) of Europe and North America: evolutionary relationships inferred from multilocus data and a unified taxonomy. Mycologia 107: 359–383. http://dx.doi.org/10.3852/14-166

Taşkın H, Büyükalaca S, Doğan HH, Rehner SA, O'Donnell K. 2010. A multigene molecular phylogenetic assessment of true morels (*Morchella*) in Turkey. Fungal Genet. Biol. 47: 672–682. http://dx.doi.org/10.1016/j.fgb.2010.05.004

Taşkın H, Büyükalaca S, Hansen K, O'Donnell K. 2012. Multilocus phylogenetic analysis of true morels (*Morchella*) reveals high levels of endemics in Turkey relative to other regions of Europe. Mycologia 104: 446–461. http://dx.doi.org/10.3852/11-180

Taylor JW, Jacobson DJ, Kroken S, Kasuga T, Geiser DM, Hibbett DS, Fisher MC. 2000. Phylogenetic species recognition and species concepts in fungi. Fungal Genet. Biol. 31: 21–32. http://dx.doi.org/10.1006/fgbi.2000.1228

Trappe MJ, Trappe JM, Bonito GM. 2010. *Kalapuya brunnea* gen. & sp. nov. and its relationship to the other sequestrate genera in Morchellaceae. Mycologia 102: 1058–1065. http://dx.doi.org/10.3852/09-232